



NFDI4
BIOIMAGE

Microscopy data storage solutions

Workshop: **Managing FAIR microscopy data at scale for universities and research institutions: an introduction for non-imaging stakeholders**

Mar 12th, 2025

Trainers: Ksenia Krooß, Christian Schmidt, **Michele Bortolomeazzi**

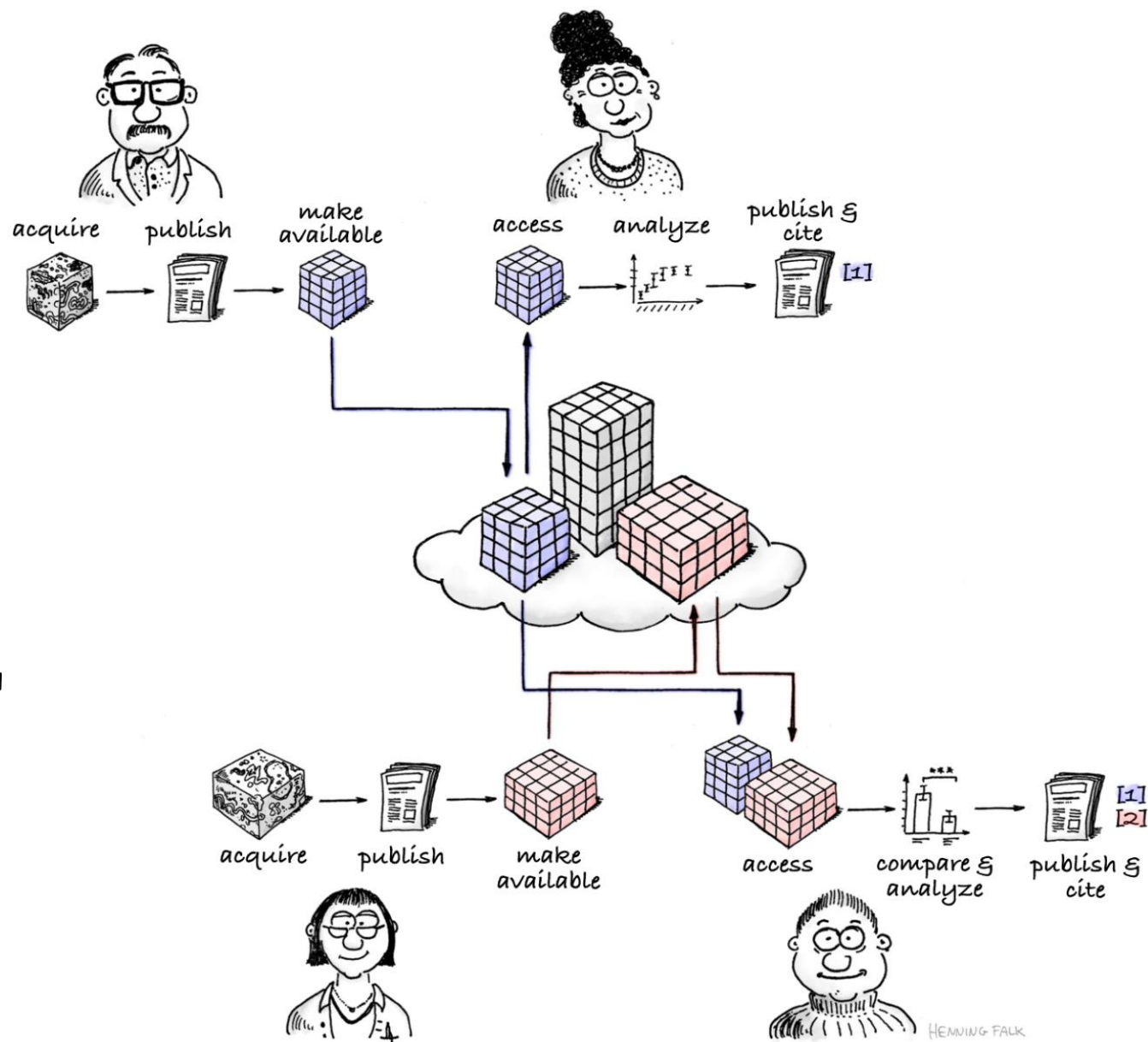
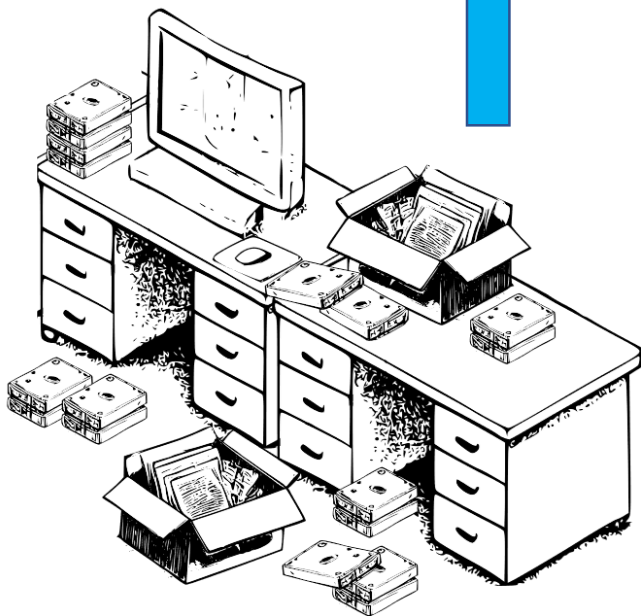
Zenodo DOI: **10.5281/zenodo.15026373**

2024-09-26



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Microscopy data lifecycle

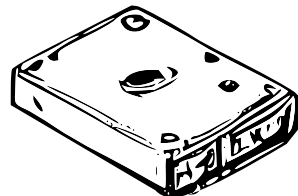


Research Data Management Challenges

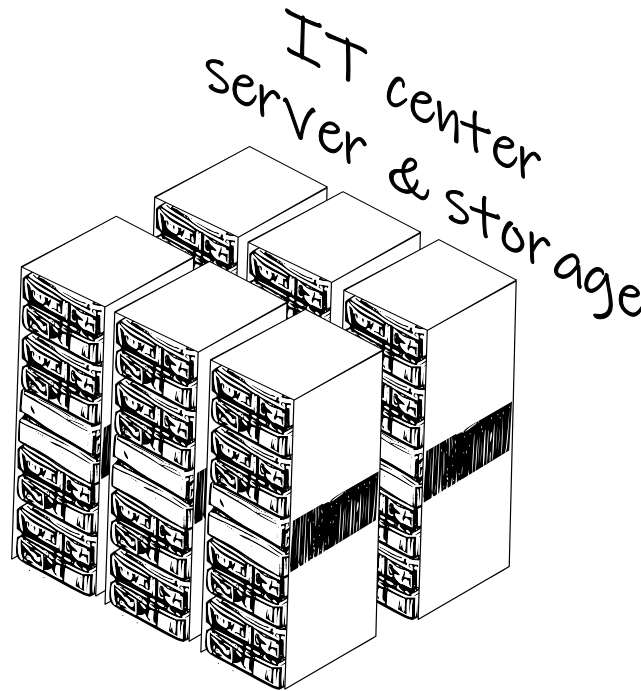
File storage and organization: the risk of data fragmentation

A collaborator doing image analysis has no access or needs to have the data locally

Send him/her a copy...

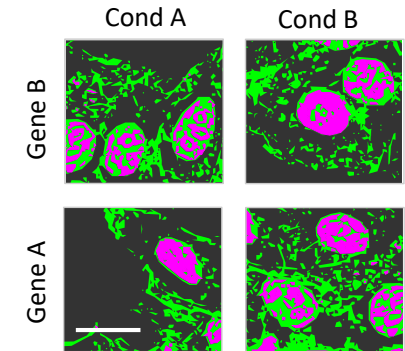


Institutional backed-up storage



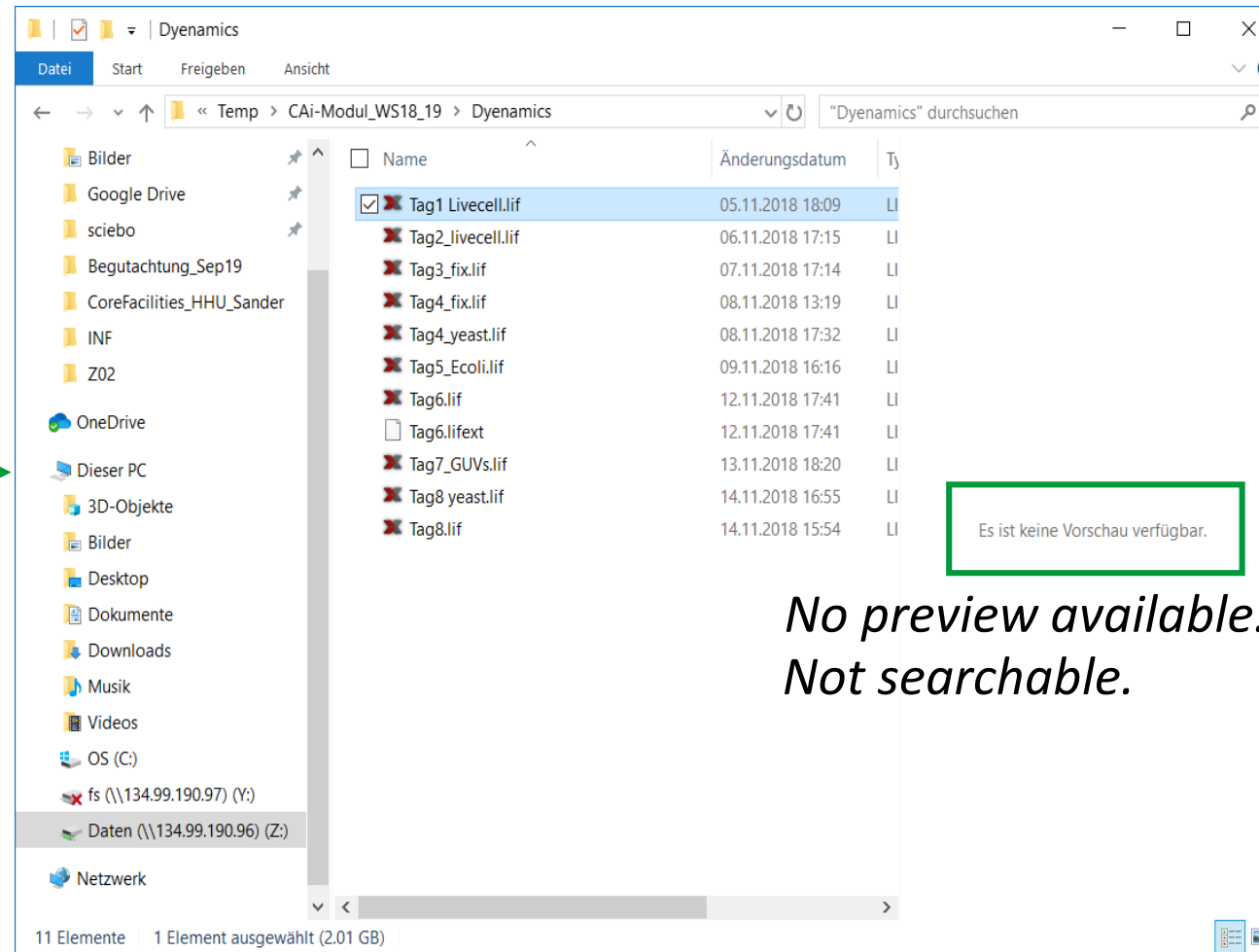
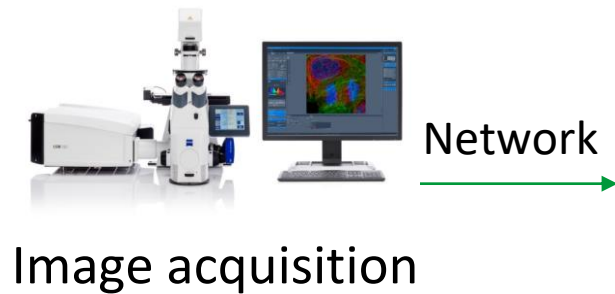
Lab meeting / seminars, etc.
→ I need to show my results:

Exporting as JPEG to create a few figures...



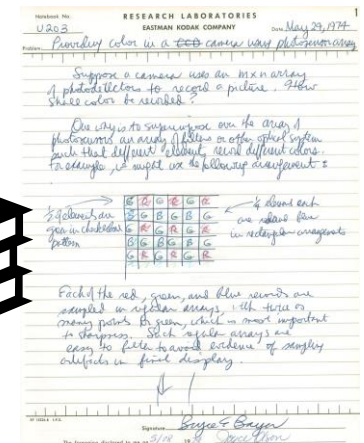
Stored on local computers, sent via emails, etc.

The data management problem in classical file browsers:



*No preview available.
Not searchable.*

Where is the metadata?



...usually it is in a
hardcover lab notebook

Courtesy of S. Weidtkamp-Peters

https://commons.m.wikimedia.org/wiki/File:Bryce_Bayer_Lab_Notebook_U203_page_1.jpg CC BY-SA 4.0

How do I even open the images ?

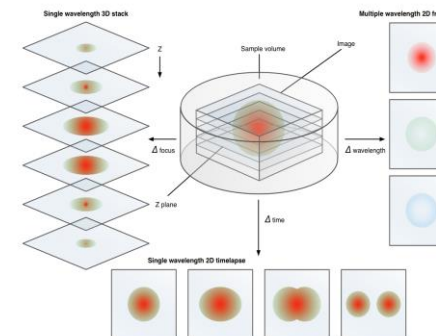
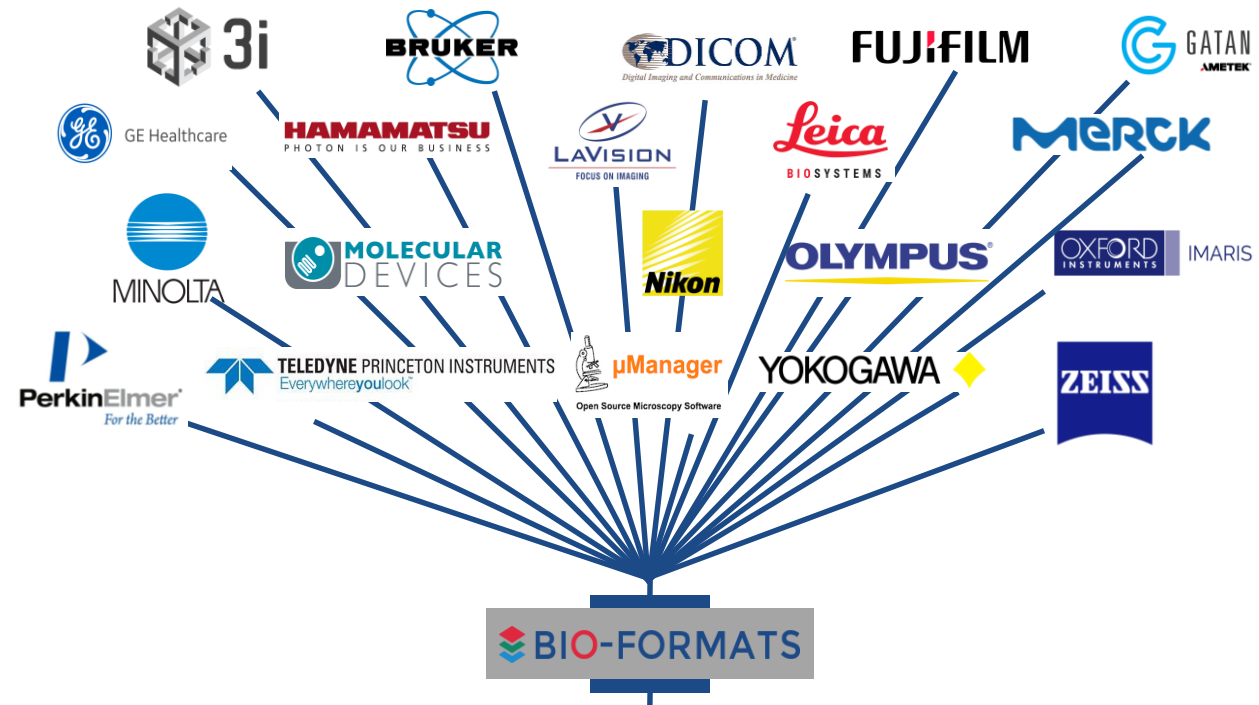
Biological images are generally saved by the microscopes in vendor specific proprietary formats (> 100 different formats).

The vendor can provide software for opening these images, but:

- License?
- Backwards compatibility?

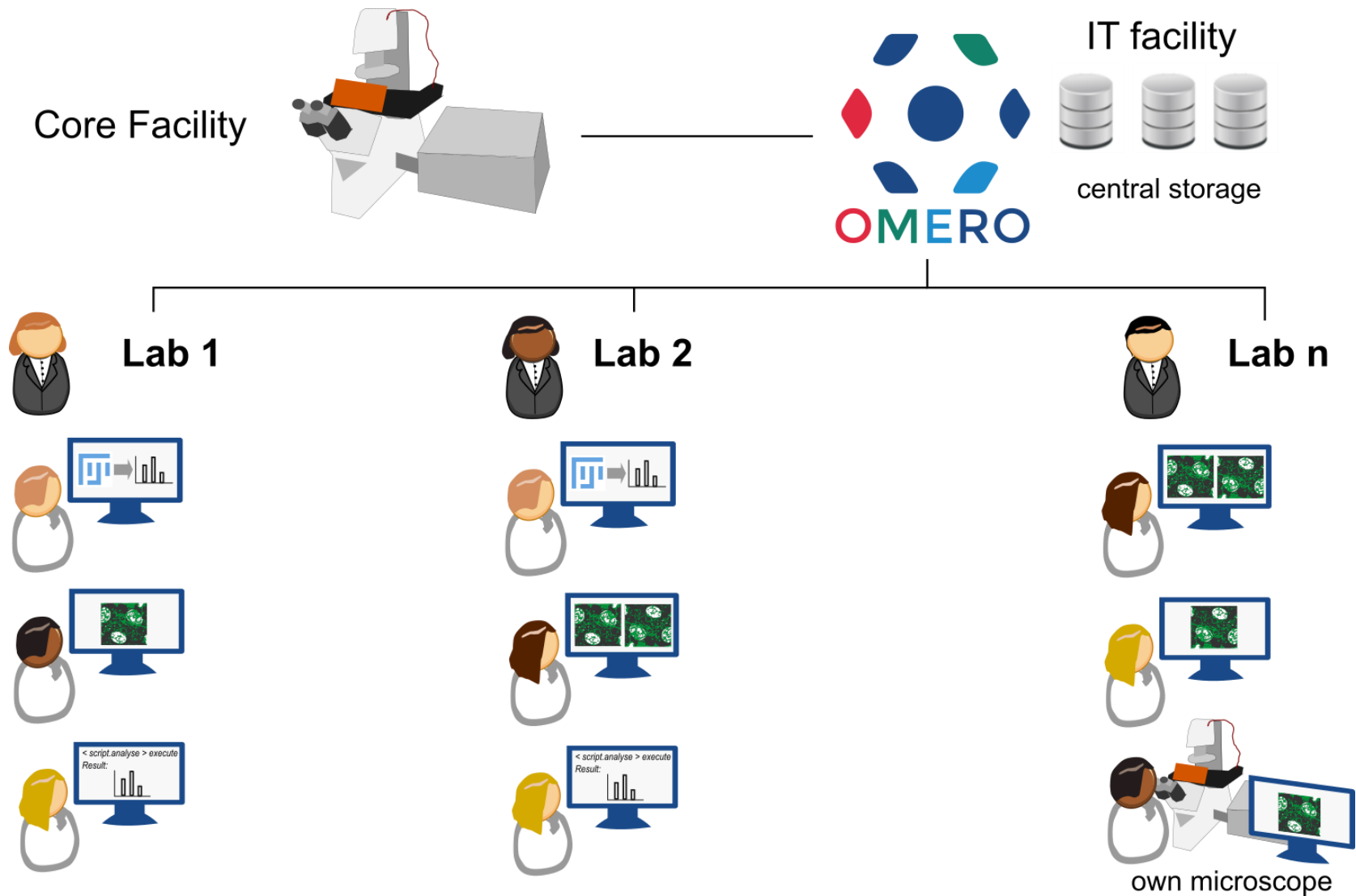
Need to convert the images to an open format, OME-TIFF, while preserving:

- Data
- Metadata



Swedlow et al. (2003) *Informatics and quantitative analysis in biological imaging*. *Science* 300(5616), 100-2.
DOI: [10.1126/science.1082602](https://doi.org/10.1126/science.1082602)

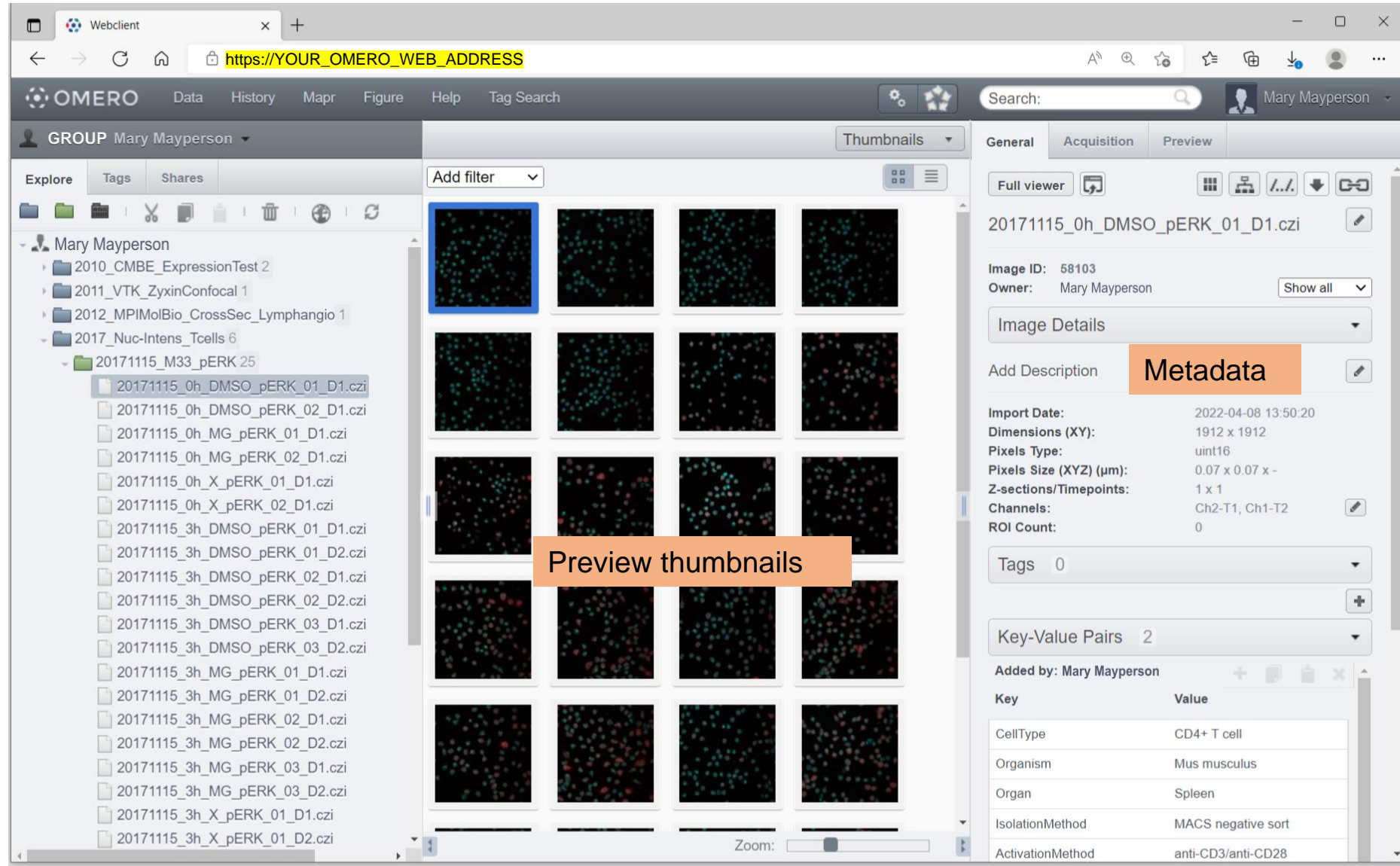
OMERO is a microscopy data management platform



How OMERO helps with data management

Example Projects and
Datasets

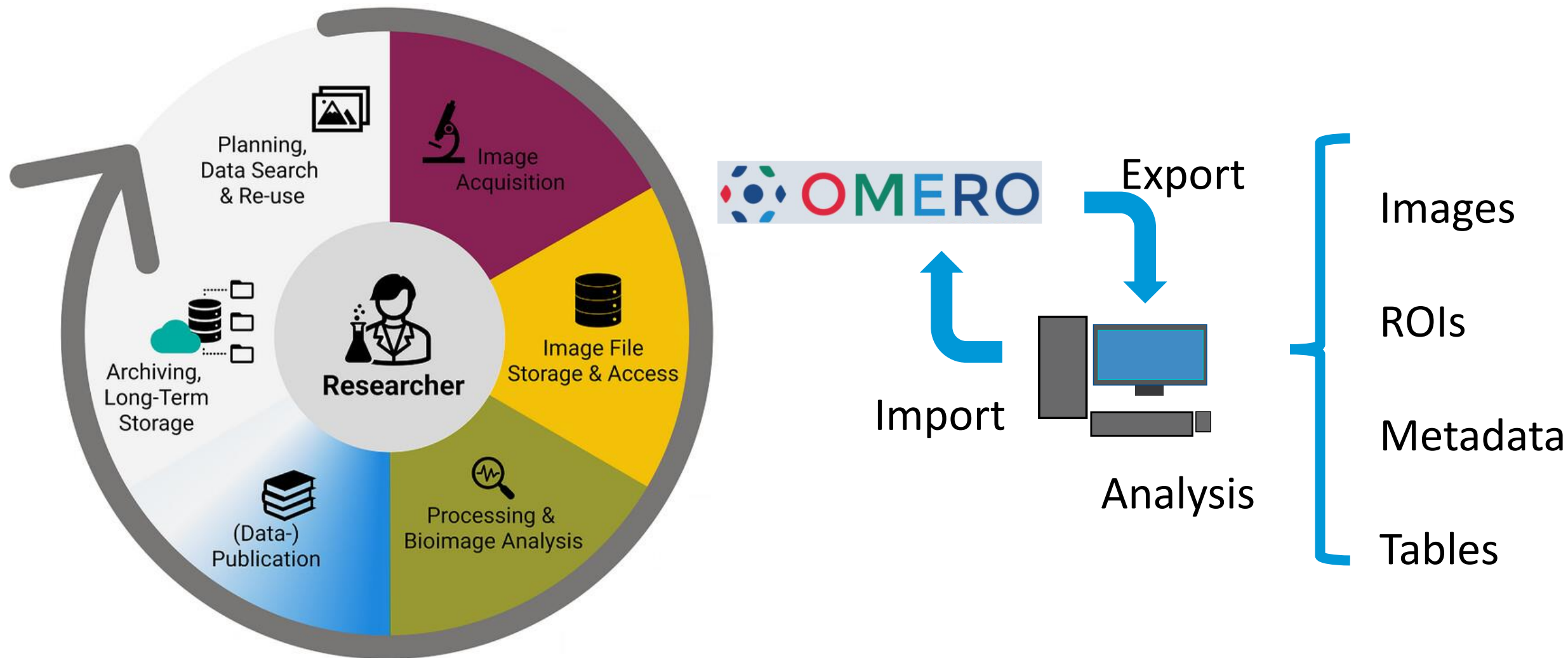
- Managed data
- Preview available
- Access to metadata
- User-friendly but machine-accessible



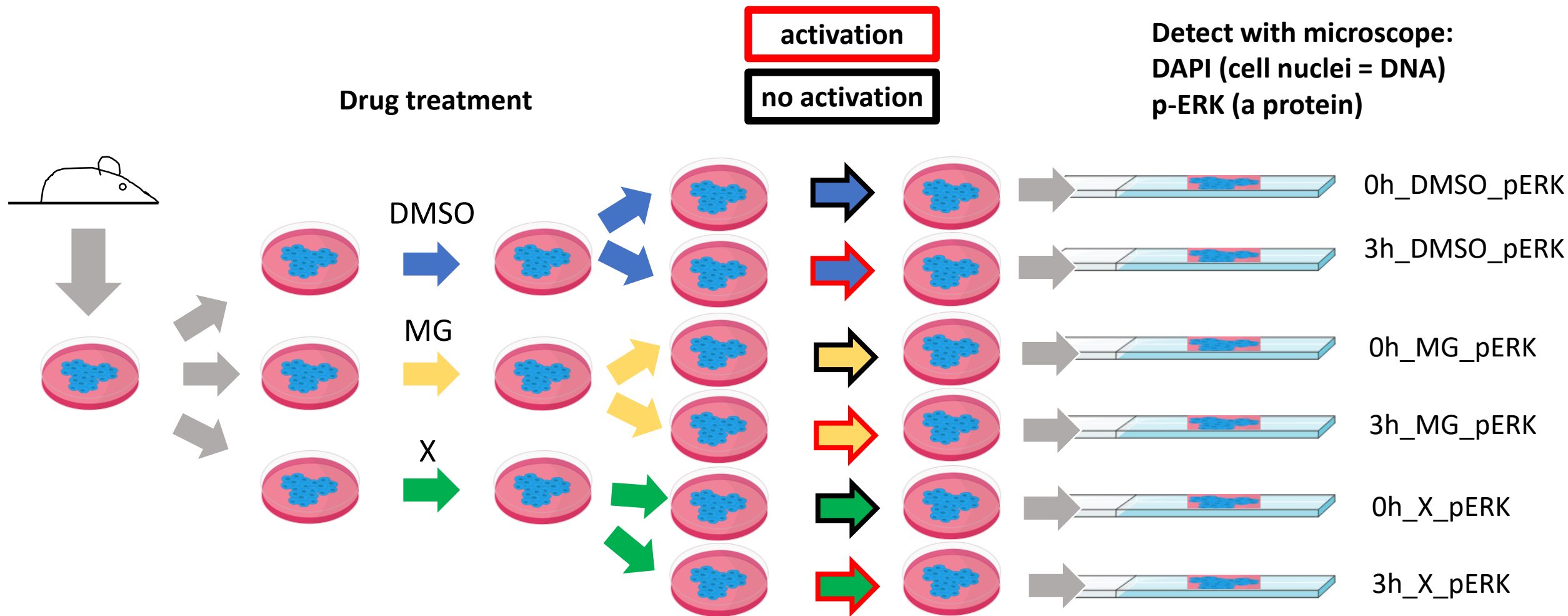
The screenshot displays the OMERO webclient interface. On the left, a tree view shows the project structure under 'Mary Mayperson', including folders like '2010_CMBE_ExpressionTest 2' and '20171115_M33_pERK 25'. The main area shows a grid of image thumbnails, with one selected and highlighted by a blue border. An orange box labeled 'Preview thumbnails' points to this grid. On the right, a metadata panel for the selected image '20171115_0h_DMSO_pERK_01_D1.czi' is visible, showing details like 'Image ID: 58103', 'Owner: Mary Mayperson', and a table of key-value pairs.

Key	Value
CellType	CD4+ T cell
Organism	Mus musculus
Organ	Spleen
IsolationMethod	MACS negative sort
ActivationMethod	anti-CD3/anti-CD28

Analysis in the data management workflow



Example layout of a biological study with bioimaging data



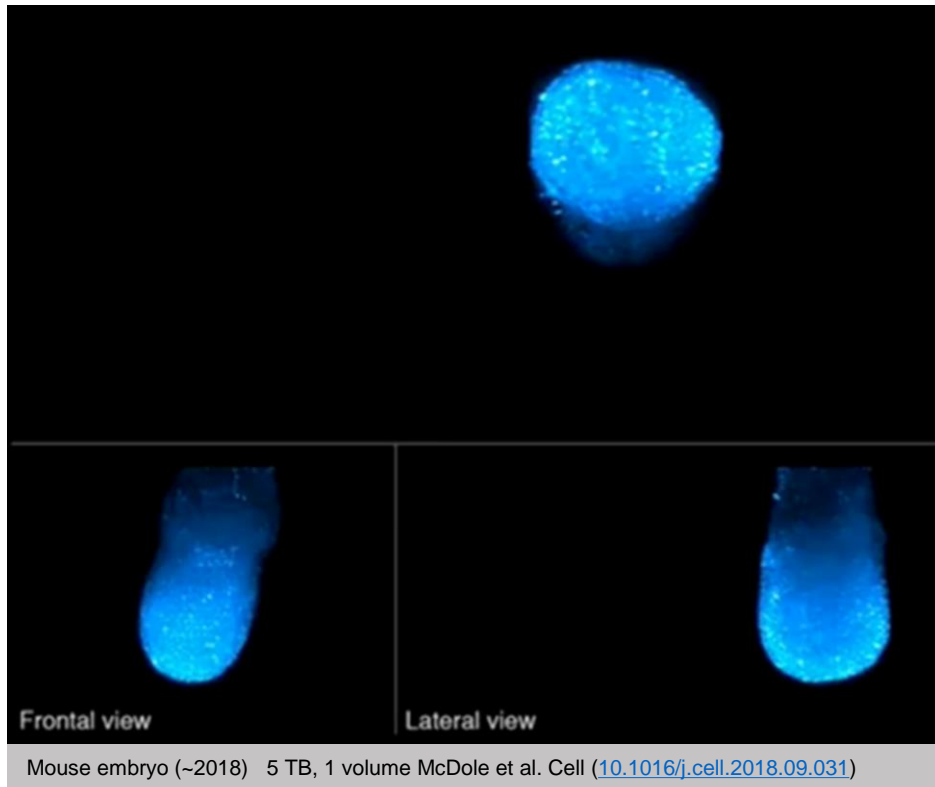
(OMERO live demonstration and self-exploration
for workshop participants)

Advantages of OMERO for RDM

- Central, backed-up storage for bioimaging data
 - In original file format, with preview options and metadata access
- Shared visualization and annotation for metadata enrichment
- Remote and controlled access for defined user groups
- Figure creation and export directly with original images
- Interfaces for image analysis available (e.g., Fiji, QuPath, etc.)
- Can be connected to ELNs

How about very large data?

Advancements in imaging technology: higher resolution, sensitivity, imaged area, ...



Mouse embryo (~2018) 5 TB, 1 volume McDole et al. Cell ([10.1016/j.cell.2018.09.031](https://doi.org/10.1016/j.cell.2018.09.031))

2169 X 2048 X 988 (xyz) pixels

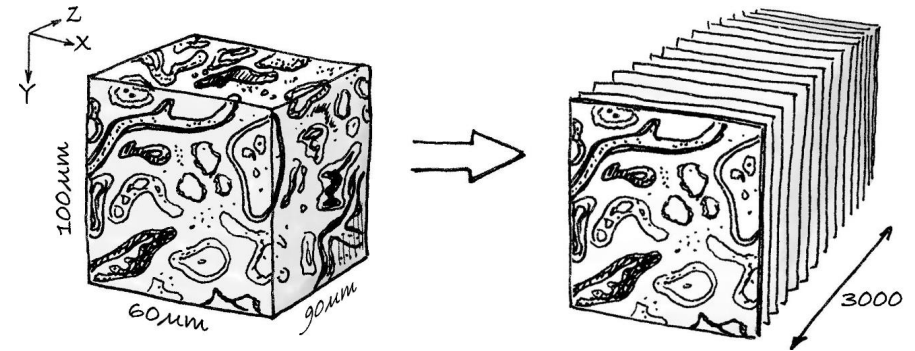
532 timepoints X 2 Channels X 16bit



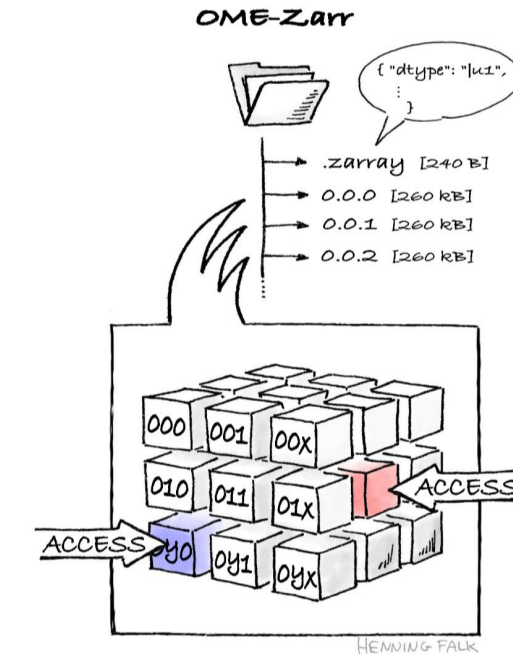
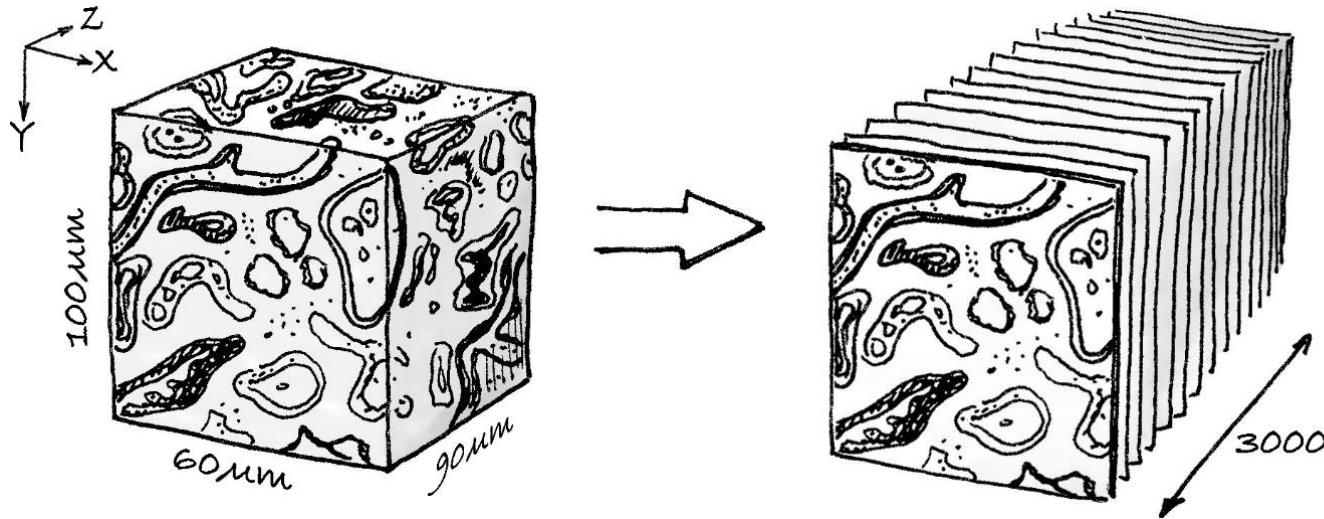
Images can have sizes in the order of multiple TBs!

How can we deal with such large images:

- Store
- View + Analyse
- Share
- ...



OME-Zarr, a chunked file format



Def. (n) directory-like layout of data rather than a single file, header information is available in formats like JSON or YAML.

Pros:

- ▶ natively supports **parallel writes**
- ▶ **server-less** access to contents
- ▶ much more **web-like** access
- ▶ can avoid costly downloads, e.g. when on S3

Cons:

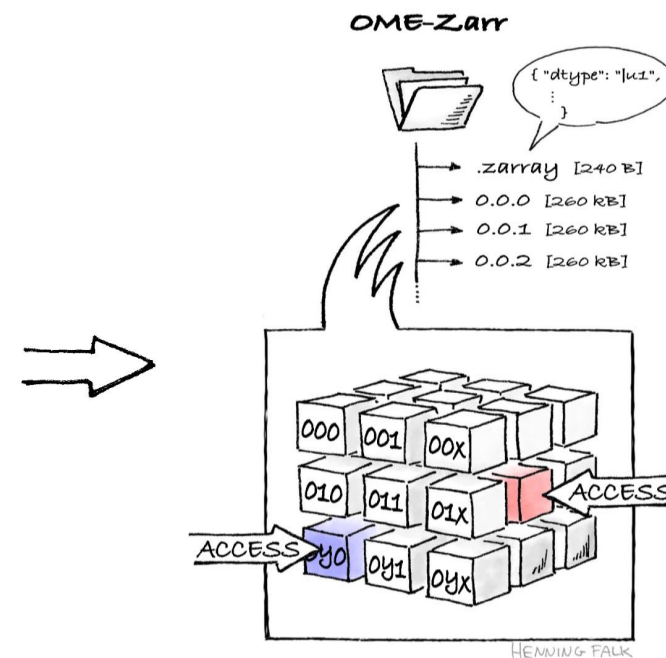
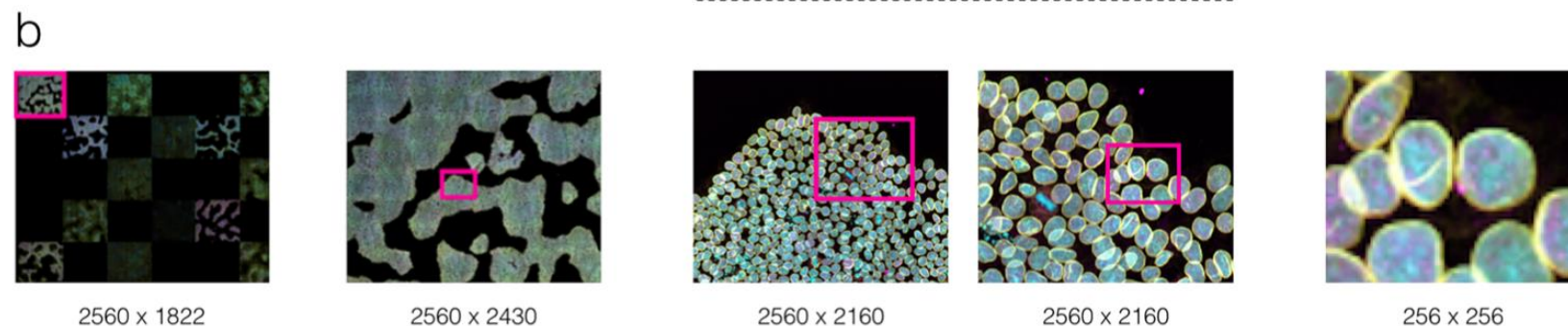
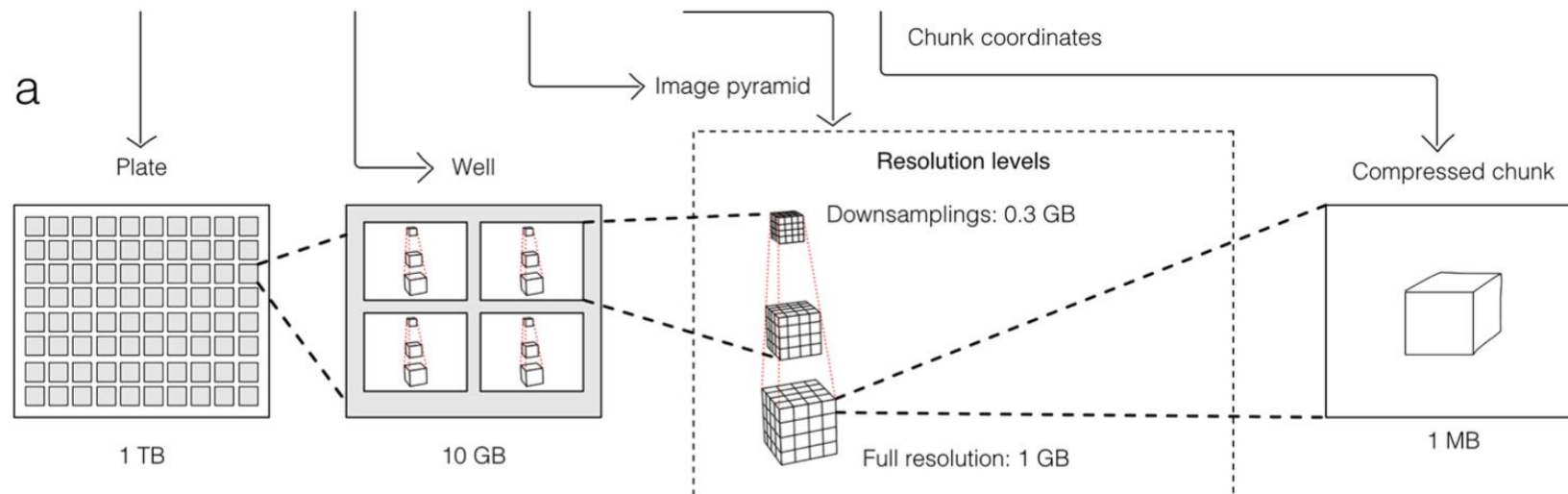
- ▶ many more files on disk
- ▶ no easy way to lock on update
- ▶ reduced desktop support



Next-generation file format
also known as OME-NGFF

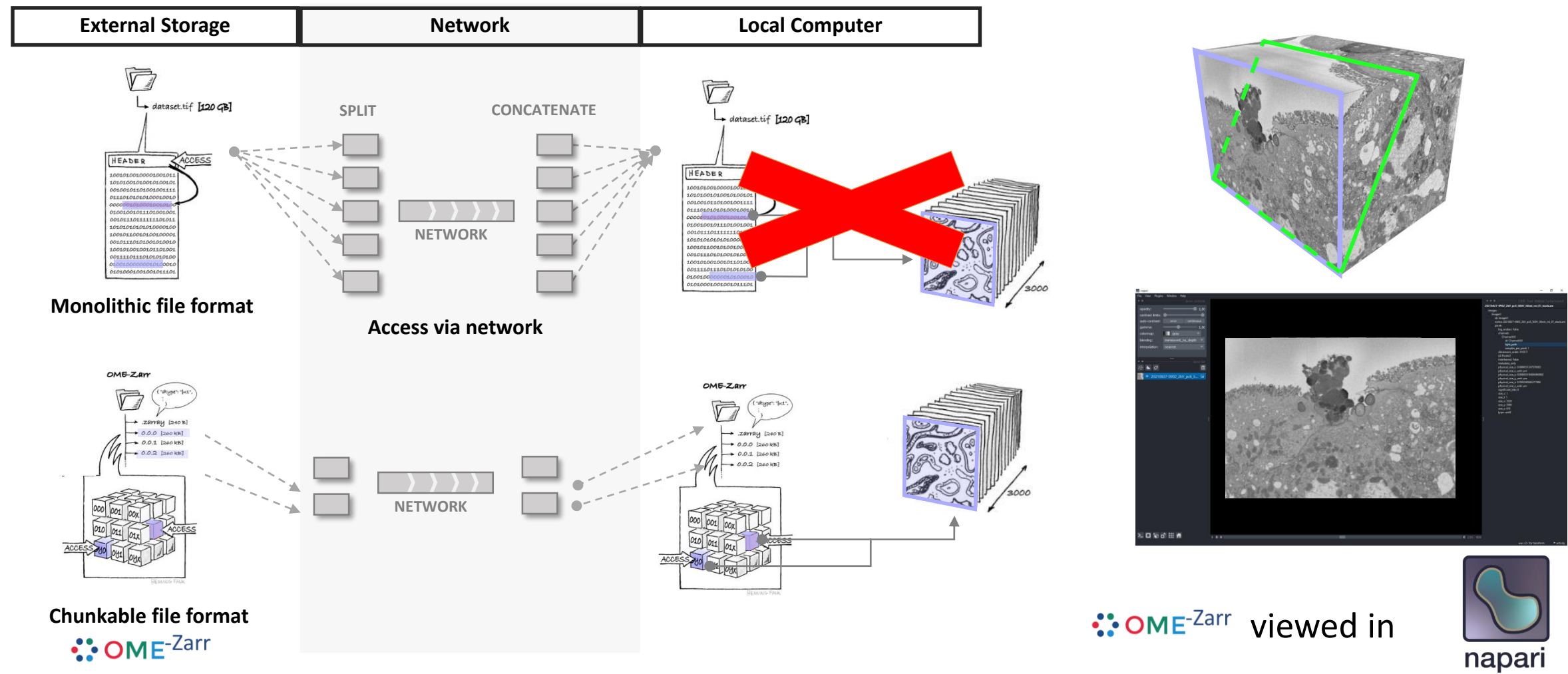
Multi-resolution, 5D+ image data

plate.ome.zarr/row/col/well/image/resolution/t/c/z/y/x

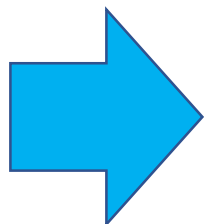
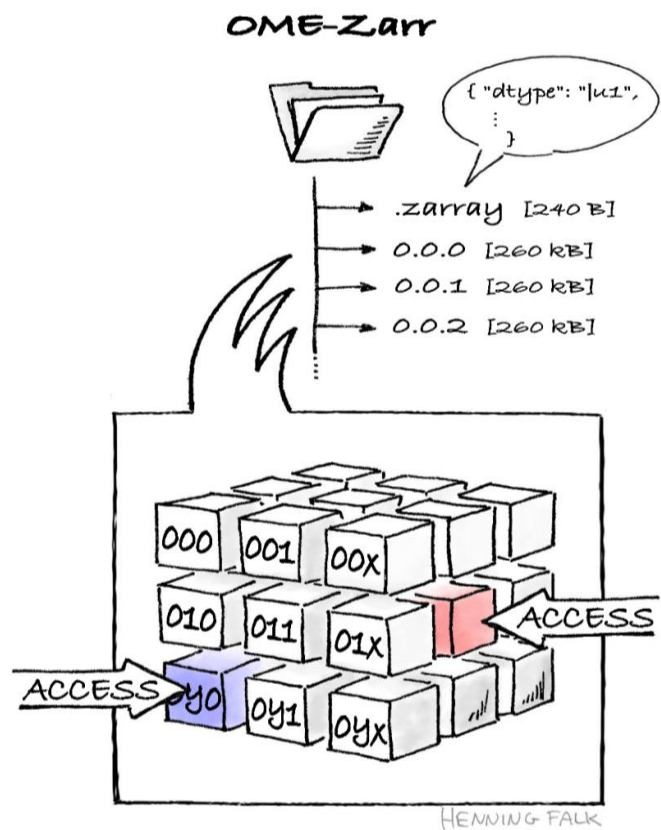


Moore et. al: Histochemistry and Cell Biology (2023)

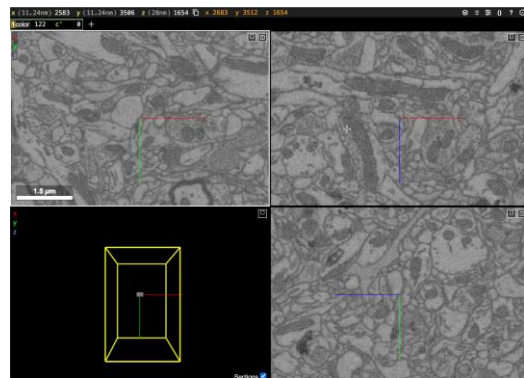
Multi-resolution, 5D+ image data



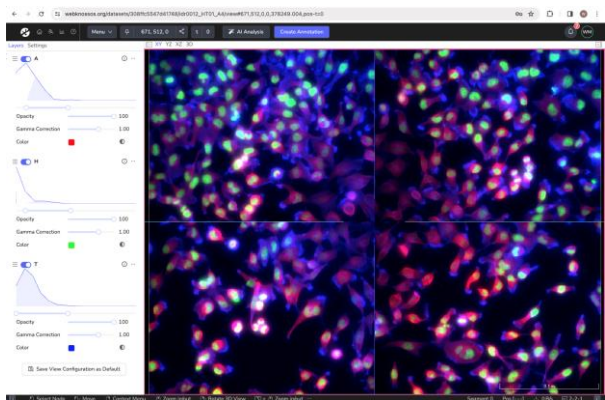
Growing support for viewing analysing



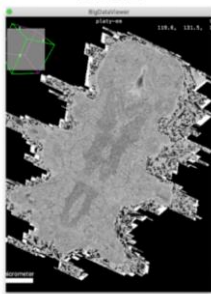
Neuroglancer



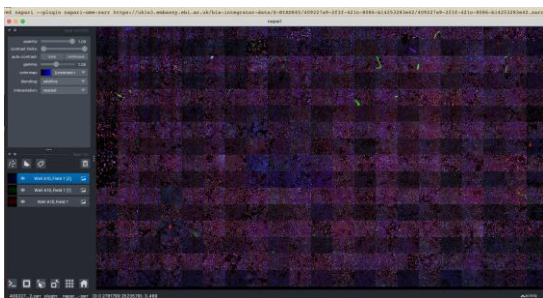
Webknossos



Fiji/BDV/MoBIE

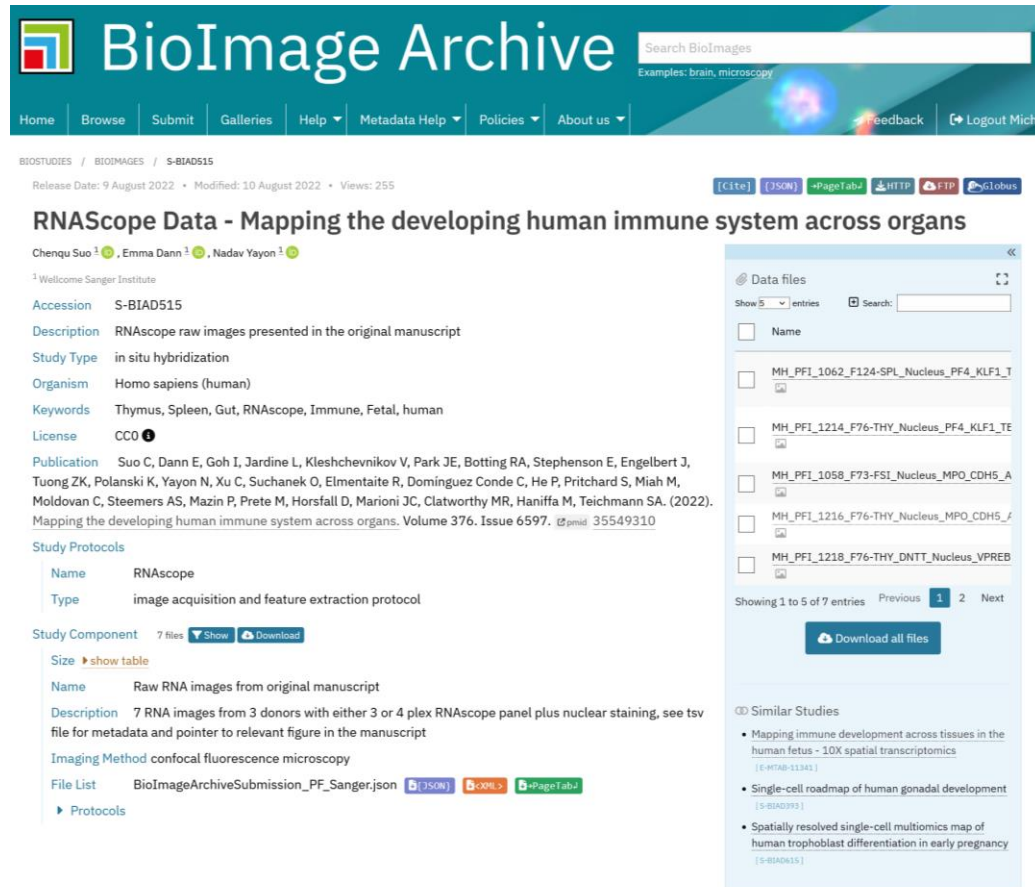


Napari



Let's explore a “small” example from the BioImage Archive

<https://www.ebi.ac.uk/biostudies/BioImages/studies/S-BIAD515>



BioImage Archive

Search BioImages
Examples: brain, microscopy

Home Browse Submit Galleries Help Metadata Help Policies About us Feedback Logout

BIOSTUDIES / BIOIMAGES / S-BIAD515

Release Date: 9 August 2022 • Modified: 10 August 2022 • Views: 255

[Cite] [JSON] [PageTab] [FTP] [SFTP] [Globe]

RNAscope Data - Mapping the developing human immune system across organs

Chenqu Suo¹, Emma Dann¹, Nadav Yayon¹

¹Wellcome Sanger Institute

Accession S-BIAD515

Description RNAscope raw images presented in the original manuscript

Study Type in situ hybridization

Organism Homo sapiens (human)

Keywords Thymus, Spleen, Gut, RNAscope, Immune, Fetal, human

License CC0

Publication Suo C, Dann E, Goh I, Jardine L, Kleshchevnikov V, Park JE, Botting RA, Stephenson E, Engelbert J, Tuong ZK, Polanski K, Yayon N, Xu C, Suchanek O, Elmentaite R, Dominguez Conde C, He P, Pritchard S, Miah M, Moldovan C, Steemers AS, Mazin P, Prete M, Horsfall D, Marioni JC, Clatworthy MR, Haniffa M, Teichmann SA. (2022). Mapping the developing human immune system across organs. Volume 376. Issue 6597. PMID 35549310

Study Protocols

Name	Type
RNAscope	image acquisition and feature extraction protocol

Study Component 7 files [Show] [Download]

Size [show table]

Name	Description
Raw RNA images from original manuscript	7 RNA images from 3 donors with either 3 or 4 plex RNAscope panel plus nuclear staining, see tsv file for metadata and pointer to relevant figure in the manuscript

Imaging Method confocal fluorescence microscopy

File List BioImageArchiveSubmission_PF_Sanger.json [JSON] [XML] [PageTab]

Protocols

Data files

Show 5 entries Search:

Name
MH_PFI_1062_F124-SPL_Nucleus_FF4_KLF1_T
MH_PFI_1214_F76-THY_Nucleus_FF4_KLF1_TE
MH_PFI_1058_F73-FSI_Nucleus_MPO_CDH5_A
MH_PFI_1216_F76-THY_Nucleus_MPO_CDH5_f
MH_PFI_1218_F76-THY_DNTT_Nucleus_VPREB

Showing 1 to 5 of 7 entries Previous 1 2 Next

[Download all files]

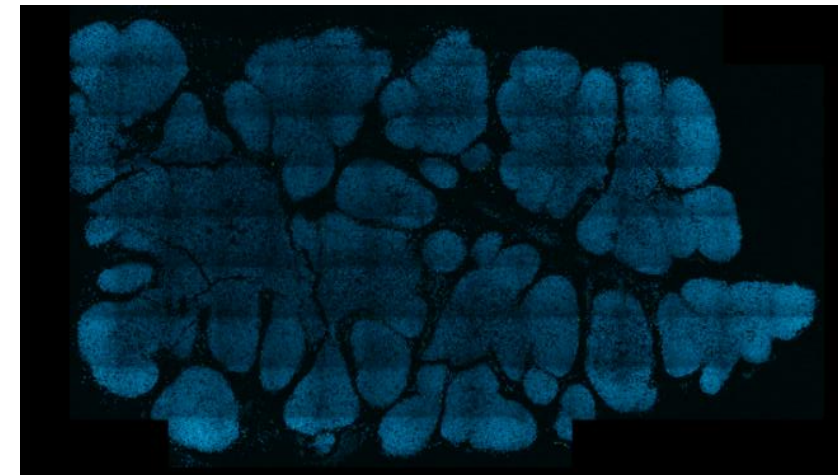
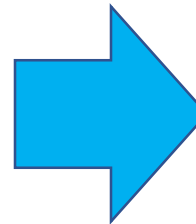
Similar Studies

- Mapping immune development across tissues in the human fetus - 10X spatial transcriptomics [E-MTAB-11341]
- Single-cell roadmap of human gonadal development [S-BIAD515]
- Spatially resolved single-cell multiomics map of human trophoblast differentiation in early pregnancy [S-BIAD515]

MH_PFI_1216_F76-THY_Nucleus_MPO_CDH5_AZU1_Meas3_A03_F1T0_none.ome.tif

15GB (20257 x 30311 x 5 Pixels, 3 Channels)

Human fetal thymus, 16 weeks



Also available from FTP (but remember, this is 15 GB!):

https://ftp.ebi.ac.uk/biostudies/fire/S-BIAD/515/S-BIAD515/Files/MH_PFI_1216_F76-THY_Nucleus_MPO_CDH5_AZU1_Meas3_A03_F1T0_none.ome.tif

15/12/22

There is a faster way!

<https://www.ebi.ac.uk/bioimage-archive/galleries/S-BIAD515/IM4.html>



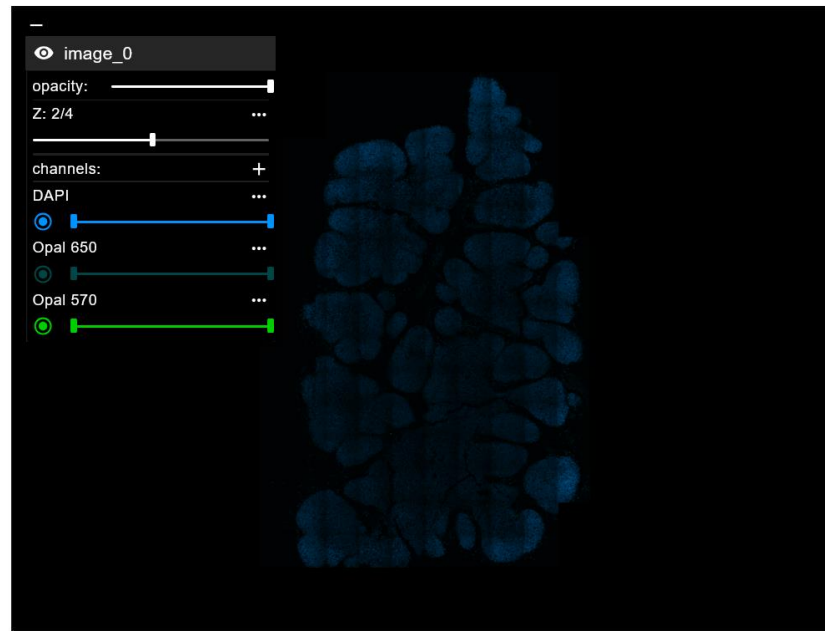
Copy S3 URI to clipboard

Open in ITK viewer

Open fullscreen in Vizarr

Open in Neuroglancer

Download original (?MiB)



MH_PFI_1216_F76-THY_Nucleus_MPO_CDH5_AZU1_Meas3_A03_F1T0_none.ome.tif

15GB (20257 x 30311 x 5 Pixels, 3 Channels)

Human fetal thymus, 16 weeks

Can you find the areas richer in blood vessels?

Hint: Zoom in and play with the **green slider**.

Also available from FTP (but remember, this is 15 GB!):

https://ftp.ebi.ac.uk/biostudies/fire/S-BIAD/515/S-BIAD515/Files/MH_PFI_1216_F76-THY_Nucleus_MPO_CDH5_AZU1_Meas3_A03_F1T0_none.ome.tif

(Dataset exploration with OME-Zarr in the
Vizarr viewer)

A FAIR Bioimage Data Vision

